Effect of Core Stability Training on Static Balance of the Children with Down Syndrome

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ABSTRACT

Purpose: This research aimed to study the effect of 8 weeks core stability training on static balance of the children with Down syndrome.

Methods: A total of 16 children with Down syndrome from rehabilitation center of Noor Abad City were selected and randomly divided into 2 groups of control (n=8) and experimental (n=8). At the pretest and posttest, subjects' static balances were evaluated by modified stork stand test. The training program was conducted in 8 weeks, 3 times a week, and each session lasted 45-60 minutes. Statistical analysis was done by dependent and independent t-test using SPSS version 21 ($P \leq 0.05$).

Results: Our results indicated a 67% progress in static balance (3.64 s) in the experimental group ($P=0.0001$) and their 84% superiority (4.14 s) over the control group in the post-test ($P=0.0001$).

Conclusion: According to these results, core stability training improves the static balance of the children with Down syndrome and can be used in their rehabilitation program.

1. Introduction

Down syndrome, previously referred to as mongolism, was discovered by John Langdon Down in 1866 [1]. This condition is considered one of the most common types of genetic disorders in mild to moderate mental retardation [2]. Down syndrome is caused by the presence of all or part of an extra chromosome in the 21st chromosome pair [3]. Since in people with Down syndrome sensory information related to spatial position and speed of movement of the body are incorrect, any attempt to establish balance leads to severe fluctuations in body [4]. Thus, the balance capacity of children with Down syndrome is far less than their normal peers [5]. Small size brainstem, delayed cerebellar maturation, lack of training programs, and limited motor experience are other causes of motor disturbances in these children [5].

Balance is a quite dynamic process that is unconsciously driven. Coordination between eyes, internal ear, proprioceptive sense, and the nervous system is a prerequisite for maintaining balance in highly variable environmental conditions. According to most researchers, in people with mental disability, the ability to maintain body posture is considerably weaker than their normal peers. This situation causes a disruption in gait pattern and increases the risk of fall and its consequences. Muscle weakness, limited range of motion, ataxia and abnormal muscle tone are negative factors affecting the balance functions [6]. Previous research shows a pos-

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itive and significant correlation between muscle weakness and balance disorders [7]. Muscle weakness in children with Down syndrome reduces their balance in standing and increases their risk of falling. Therefore, development of muscle strength and maintaining it at an optimum level is one of the important educational issues for children with Down syndrome [8].

However, studies have shown that if these children do regular physical exercise, their balance growth potential will be better than other groups with mental retardation [5, 9]. These findings stress the need to develop special and efficient motor programs for children with Down syndrome. In recent years, the core stability exercises are of interest to researchers in the field of improving the balance functions of children with disabilities. In humans, the lumbar, pelvic, and femoral areas and the muscles around them are referred to the central area of the body. Because of its specific anatomic position, this area is responsible for the movement of the center of gravity in movements [10]. Core stability area is like a box that abdominal muscles form its anterior section, muscles of the spine and gluteal muscles form its posterior section, diaphragm muscle forms its roof, and pelvic girdle muscles form its floor [11]. The central stability muscular system supports the spine throughout the range of motion and trunk muscles and ligaments with their physiological function help to maintain body stability and control at the lumbar vertebrae. The lumbar, abdomen and thigh muscles are highly coordinated while generating power for dynamic balance [10].

According to a classification, core stability muscles are divided into superficial and deep groups [12]. The role of deep muscles is supporting the joints and creating stability, and superficial muscles are involved in discontinuous activities and the functions associated with them. Superficial muscles are usually larger and cause motion through concentric contraction [13]. These muscles, which are formed by fast-twitch muscle fibers, as the principal mover of the spine, are responsible for the transfer of force from the lower to the upper limbs [14]. The stability of the central zone depends on the quality of the interaction of the active, passive, and nervous systems. Passive system comprises the spine, joint, intervertebral discs, spinal ligaments, joint capsules, and passive mechanical properties of muscles.

Muscles and tendons around the spine form the active system and the nervous system, as the motor converter in the ligaments, tendons, muscles and nerve control centers, coordinates the actions of the other 2 systems. The interaction between the 3 systems leads to core stability, improved functioning of the nervous-muscular system, enhanced muscle strength as well as endurance and stability of the trunk and pelvis [13, 15]. Thus, core stability training is designed with the aim of developing the endurance and coordination of core stability muscles and achieving the necessary physical capacity to maintain the natural state of the spine in daily activities [16].

Despite rich theoretical principles, core stability training is inexpensive and due to its ease of implementation, it is compatible with physical and mental capacity of children with Down syndrome. However, few studies have examined its effect on these children. As a result, the aim of this research was to study the effect of core stability training on static balance of children with Down syndrome. Improving this form of balance will increase self-confidence, reduce the risk of fall, and promote these children's participation in social and recreational activities [9].

2. Materials and Methods

The present study was a quasi-experimental study with pretest-posttest method and the control and experimental groups. Subjects were selected (8 girls and 12 boys) from the children with Down syndrome referred at Nurabad rehabilitation center. Twenty children whose parents were volunteered to let their children participate in the study were randomly divided into 2 control and experimental groups. Inclusion criteria were parental consent, 8-13 years old, having no neurological or mobility disorders, and with lower extremity health. This information was obtained by providing health questionnaire to parents. Exclusion criteria included refusal or failure to understand instructions of the researcher, changing the city of residence, absence for more than 4 sessions or 2 consecutive sessions of training. During the study, 2 girls from the experimental group were excluded from the study due to absence from training and 2 boys from the control group due to changing the city of residence. Thus, finally the subjects were 16 children who were studied in 2 experimental and control groups (each 8 subjects).

Experimental group subjects performed Jeffrey's core stability exercises for 8 weeks, 3times a week, and each session lasted 45-60 minutes [17]. Table 1 presents the contents of exercise sessions [18]. To evaluate static balance, modified stork test was used. Method of conducting the test is as follows: The subject stands on one leg on a flat surface and the other (free) leg is raised up to the level of the ankle of the dominant leg. Arms are placed freely to the sides. The test is completed when the subject's free leg is placed on the floor. The tester uses a chronometer to record the maximum time the subject stands on one leg in terms of seconds. This test, with an acceptable validity, reliability of 0.87, and objectivity of 0.99 [19], was performed 3 times for each leg and the best time obtained is registered as a record. Statistical operations were conducted using descriptive statistics for calculating central indexes, distributions, etc. Kolmogorov-Smirnov test was

Table 1. Protocol of core stability exercises.

Week	Form of exercise	The volume and intensity of exercise
1, 2	- Contracting abdominal muscles while lying in a supine position - Contracting abdominal muscles while lying in a prone position - Contracting abdominal muscles while in a squat position	Three sets, 20 repetitions in each set Three sets, 20 repetitions in each set Three sets, 20 repetitions in each set
3	- Contracting abdominal muscles while lying in a supine position with one leg stretched and the other bent at knee and pressed against the abdomen - Contracting abdominal muscles while lying in a prone position with one leg stretched and the body weight on the other leg which is bent at knee - Side bridge	Three sets, 20 repetitions in each set Three sets, 20 repetitions in each set Six sets, 10 seconds pause in each set
4	- Contracting abdominal muscles while lying in a supine position and pulling the limbs upward with arms and legs kept close together - In squat position, one leg is raised and pulled outward and backward - Swinging the trunk while one arm bears the weight of the body	Three sets, 20 repetitions in each set Three sets for each leg, 20 repetitions in each set Three sets for each side, 20 repetitions in each set
5	- Sitting on the Swiss ball and stiffening the abdomen - Doing squats while Swiss ball is held on the shoulders - Raising the legs and arms simultaneously while in a prone position	Three 10-second sets Three sets, 15 repetitions in each set Three sets, 10 repetitions in each set
6	- Bending 45 degrees to the left or right - Bridging while shoulders and hands are on the floor and one leg is raised - Contracting abdominal muscles while lying in a supine position on the Swiss ball	Three sets for each side, 12 repetitions in each set Three sets for each leg, 10 repetitions in each set Three sets, 20 repetitions in each set
7	- Bending the trunk to the sides while lying on the Swiss ball in a supine position - Doing the above exercise while one arm bears the weight of the body - Raising the legs while in a side bridge position	Three sets for each side, 15 repetitions in each set Three sets for each hand, 15 repetitions in each set 10 repetitions for each side with 10-second pause
8	- Lying on the Swiss ball in a supine position and contracting abdominal muscles and raising one leg - Raising the opposite arm and leg while doing squats - Bridging while the legs are placed on the Swiss ball and one leg is raised	Three sets, 20 repetitions in each set Three sets, 20 repetitions in each set Three sets for each side with 15-second pause for each side

sued to ensure normal distribution of data, and dependent and independent t tests were used to determine significant differences between and within groups at a significance level of $P \leq 0.05$. All analyses were done by SPSS version 21.

3. Results

Table 2 presents demographic information of the studied groups. As it is seen, the differences between the means of the 2 groups indexes are not statistically significant ($P > 0.05$).

According to Table 3, results of dependent t test indicate 67% progress of the experimental group in the posttest (3.64 seconds) (P=0.0001). However, inconsiderable progress of the control group (0.1 second) is not statistically significant (P=0.653). Also, the results of independent t test indicate that the mean of the results of the experimental group in posttest is 84% (4.14 seconds) better than that of the control group (P=0.0001).

4. Discussion

The present research indicated that 8 weeks core stability training (3 times a week) improves static balance of children with Down syndrome. In the literature, no research was found on the effect of this kind of training on the balance of these children. Thus, the obtained results are compared with the findings of few researchers who

Table 2. Demographic information of the studied groups.

Characteristic	Group	Mean	F	P
Age (y)	Control	9.87±1.64	0.059	0.812
	Experimental	9.62±1.68		
Height (cm)	Control	134.12±8.5	0.265	0.615
	Experimental	134.1±10.5		
Weight (kg)	Control	37.06±5.51	0.842	0.347
	Experimental	28.72±12.1		

Table 3. Results of dependent and independent t test of significance of differences.

Groups	Pre-test	Post-test	Dependent t	P
Experimental	5.42±1.35	9.06±2.03	9.661	0.0001*
Control	4.82±1.41	4.92±1.28	0.47	0.653
Independent t	0.877	4.81		
p	0.395	0.0001*		

* Significance

have studied the effect of other exercises on the balance of children with Down syndrome or have studied the effect of core stability training on the balance of healthy individuals or individuals with other disabilities.

In their study, Sayadinezhad et al. (2013) concluded that progressive resistance training increases balance capacity in children with Down syndrome. Consistency of these findings with the results of the present research suggests the importance of increasing muscle strength in order to improve balance, because progressive resistance training elements were also present in the training protocol of the present study in the form of weight bearing exercises [20].

What is noteworthy about comparison of the 2 independent variables is the ease of implementation of core stability training and its higher compatibility with the mental capacity of children with Down syndrome compared to progressive resistance training. Kozub (2003) considered a child's motivation to move as a complex phenomenon (cited in Krebs & Block, 1992) and believed that mentally retarded children, unlike their normal peers, do not engage in an activity merely for the sake of moving, because weakness in learning and generalization of skills, deprives them of the pleasure of physical activity. Therefore, researchers should justify their choice of recommended exercise for these children [21].

The research conducted by Hesari et al. showed that 8 weeks of core stability training improves static balance of students with hearing impairments [22]. The results of the studies conducted by Jankowicz et al. and Gupta and Rao showed that balance of children with Down syndrome was affected by regular physical activity [6, 23].

The reports and findings of this study suggest that in children with Down syndrome, the ability to maintain body posture, as an important factor in adapting to life conditions, is influenced by exercise and researchers should seek to develop scientific ways to use exercise. The idea of using core stability training to improve balance is based on the theory of the systems. According to this theory, the exercise should meet the requirements for increasing the level of interaction between the nervous, muscular, and skeletal systems, which as a whole is called posture control system [24]. Because the ability to maintain balance and performing subsequent moves requires a combination of sensory data to determine the position of the body in space and apply appropriate forces by skeletal muscles. However, the ability to maintain balance depends on other factors such as muscle characteristics, joint range of motion, and biomechanical relationship between various body parts [24].

This study showed that core stability exercises increase static balance of children with Down syndrome through developing strength and endurance of superficial and deep muscles of core stabilization area. The mechanism of this effect is probably related to integration of proprioceptive feedback due to closed chain movements such as squatting on the Swiss ball.

This integration, on the one hand, reduces the shear force of the joints and, on the other hand, increases the activity of proprioception in the joints and tendons. And since proprioceptive sense helps maintain the balance through transmission of information to the central nervous system, core stability exercises strengthen the body's balance mechanism [14]. However, the research conducted by Sharma et al. showed that these exercises have little effect on the static balance of volleyball players [25]. This inconsistency can be explained with the significant differences in motor opportunities of volleyball players and children with Down syndrome.

In conclusion, core stability exercises have a positive effect on the static balance of children with Down syndrome. Because of the importance of this form of balance in everyday human life, stability exercises can be considered an important part of the physical and social rehabilitation program for these children.

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